

Engineering Applications in Differential and Integral Calculus*

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The authors describe a two-year collaborative project between the Mathematics and the Engineering Departments. The collaboration effort involved enhancing the first year calculus courses with applied engineering and science projects. Two enhanced sections of the differential (first semester) and integral (second semester) calculus courses were offered during the duration of the project. The application projects involved both teamwork and individual work, and we required use of both programmable calculators and Matlab for these projects. Some projects involved use of real data often collected by the involved faculty. The paper lists all the projects, including where they fit within the course topics. Some selected projects are described in detail for both the differential and the integral calculus courses. The paper also summarizes the results of the survey questions given to the students in two of the courses followed by the authors own critique of the enhancement project.

INTRODUCTION

AT PENN STATE, most of Math 140 covers differential calculus, while about 30% of the course is devoted to integral calculus. Among the topics covered are: limits and rates of change, continuous functions, derivatives of polynomials, rational functions, trigonometric functions, curve sketching and optimization, applied word problems, the Riemann integral and the Fundamental Theorem of Calculus, areas between curves, and volumes of solids of revolution. Almost all of the topics covered in Math 141 involve the integral calculus including: inverse functions, derivatives and integrals of exponential and logarithmic functions, techniques of integration, infinite sequences and series, parametric equations, and polar coordinates.

From Fall 1997 to Spring 1999, we offered enhanced sections of the Math 140 and Math 141. The objectives were:

- to introduce team-based projects in engineering and science,
- to convey to the students the importance of mathematics in engineering and science,
- to use Matlab and graphics calculators to analyze experimental data and perform mathematical operations.

We offered one enhanced section of Math 140 in Fall 1997 and also in Fall 1998. We also offered one section of enhanced Math 141 in Spring 1998 and in Spring 1999. In this paper, we will describe

the projects used, the grading system, and survey results of the students' experiences.

BRIEF DESCRIPTIONS OF THE PROJECTS

The following are the projects (with pertinent mathematical topics in parentheses) we used in the enhanced section. In the next section, selected projects are described in detail.

Math 140 Projects, Fall 1997

1. Data on strength of basswood samples (fitting data with linear and polynomial functions)
2. Temperature data from State College, Pennsylvania (fitting data with sine functions, comparing average and instantaneous rates of change)
3. Beam analysis in mechanics (piecewise linear, quadratic, and cubic functions, and differentiability of a function)
4. Electrical circuit analysis (exponential functions and derivatives)
5. Fitting a pipeline with minimal cost (optimization of a function on a closed interval)
6. Crankshaft design (optimization of a function on a closed interval)

Math 141 Projects, Spring 1998

1. Analysis of beams in mechanics (polynomial integration and optimization of a function on a closed interval)
2. Tuning a radio (integration of sine and cosine functions)
3. Application of parametric curves (Cubic Bezier Curves)
4. Wrecking ball (approximating an integrand)

* Accepted 25 June 2001.

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Rachel S Tattersall



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